



Harmful algal blooms in water supply and recovery systems: Investigating accumulation phenomenon and management strategies

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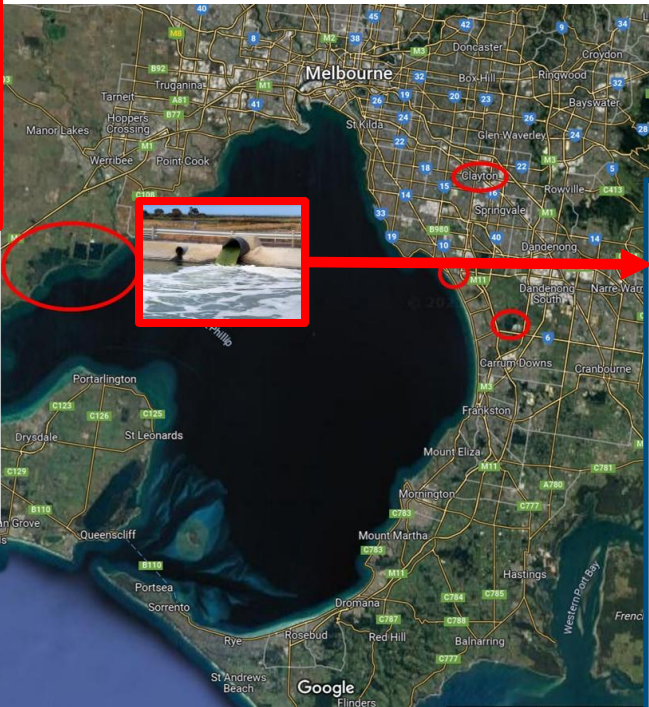
Our mission:

- Smart systems including machine learning approaches for identifying, quantifying and modelling microorganisms in water, wastewater and reuse supply systems
- Eliminating the microbial threats to water quality through sustainable advanced treatment

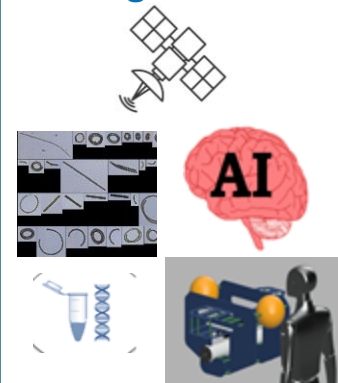
Our new but growing team of PhD students & postdocs:



Fresh water & alternative sources in urban and regional/remote area



Smart diagnostics



Advanced water & wastewater treatment within circular economy



Manufactured water

Risk management & Public health



Hydrogen economy



Toxic and nuisance blooms are within our water supply systems:



List of Potentially Toxic Cyanobacteria

Cyanobacteria (also known as blue-green algae) pose a significant health hazard in public water supplies and recreational water bodies. Risk assessment is based on species identification and potential for toxin production. Thus, correct identification and reporting of toxic species is vital to stakeholders. Currently there is no uniform agreed list of species recognised as being potentially toxic within Australian waters; in fact, a recent survey found a large disparity in the respective lists maintained by accredited laboratories as to which species they consider as being potentially toxic. This fact sheet provides an up-to-date list of toxic species for all stakeholders.

What Has Changed?

Taxonomic revisions (name and classification changes) regularly occur which can make tracking toxigenic species over time difficult. Often industry professionals only become aware of these changes via their own literature search or acquire 'third hand' from others in the industry. Further, there has been an increasing awareness and identification of benthic toxic cyanobacteria, with several new records described from Australia. The current NHMRC Drinking Water Guidelines (2018) are only revised periodically and do not reflect these developments. Further confusion also arises due to large geographical disparity in toxin production for some species. Strains of a species can be non-toxic or vary in their toxin content. For instance, there are species known to be toxic elsewhere (eg. *Planktothrix agardhii* in Europe), which haven't been recorded to be toxic in Australia; and vice versa.

Clarification of 'Potentially Toxic'



Cyanobacteria breakthrough into flocculation system:



Water Research
Volume 152, 1 April 2019, Pages 96-105



Diagnosing water treatment critical control points for cyanobacterial removal: Exploring benefits of combined microscopy, next-generation sequencing, and cell integrity methods

Arash Zamyadi^{a, b, c}, Caitlin Romanis^d, Toby Mills^d, Brett Neilan^d, Florence Choo^b, Lucila A. Coral^{b, e}, Deb Gale^f, Gayle Newcombe^g, Nick Crosbie^h, Richard Stuetz^a, Rita K. Henderson^b



<https://doi.org/10.1016/j.watres.2019.01.002>

RESEARCH ARTICLE | MARCH 22 2021

Toxic cyanobacteria in water supply systems: data analysis to map global challenges and demonstrate the benefits of multi-barrier treatment approaches

Arash Zamyadi; Caitlin M. Glover; Attika Yasir; Richard Stuetz; Gayle Newcombe; Nicholas D. Crosbie; Tsair-Fuh Lin; Rita Henderson

<https://doi.org/10.2166/h2oj.2021.067>

We need to look into this is systematic way?

Project objectives & plan:

- (1) investigate the factors that cause accumulation
- (2) discuss feasible interventions to break the cycle of cell accumulation so as to reduce the overall risk that these compounds will occur in the product water

>> Rebecca Wells, Tim Cummins, Alina Saeed and Paula Mastroppolito from Mallee Regional Innovation Centre which is a partner in the Victoria Drought, Resilience, Adoption and Innovation Hub and leads the North-West Irrigated Horticulture Node,

>> David Sheehan, Sallyanne Bartlett, and Phillip Fasham from Coliban Water,

>> Julienne Krake, and Vijay Ignatius from Lower Murray Water,

>> Steven Newham and Karen Rouse from Goulburn Valley Water,

>> Kendal Krause and Bridey Pearn from North East Water,

>> Steven Myers, Brad Snibson and Susan Cassar from ALS Global, and

>> Carolyn Bellamy and David Bergmann from Water Research Australia.

The generous funding from the Australian Government's Future Drought Fund was the key element in realisation of this project.

Sampling point	Analysis
Raw water	<ul style="list-style-type: none"> • Cyanobacterial/algal speciation and cell count • T&O measurements - (MIB and Geosmin) • Algal Toxins – Anatoxin-A, Cyndrospermopsin, <u>Deoxycylindrospermopsin</u>, Microcystins as LR, Nodularin • Only Phase 2: qPCR for Total Cyanobacteria (16S rRNA) & Toxin <u>Genes</u> (<u>mycE/ndaF</u>, <u>cyrA</u> & <u>Sxt A</u>)
Clarified water	<ul style="list-style-type: none"> • Cyanobacterial/algal speciation and cell count • T&O measurements - (MIB and Geosmin) • Algal <u>Toxin</u> – Anatoxin-A, Cyndrospermopsin, <u>Deoxycylindrospermopsin</u>, Microcystins as LR, Nodularin
Sludge from clarifiers	<ul style="list-style-type: none"> • Cyanobacterial/algal speciation and cell count • T&O measurements - (MIB and Geosmin) • Algal <u>Toxins</u> – Anatoxin-A, Cyndrospermopsin, <u>Deoxycylindrospermopsin</u>, Microcystins as LR, Nodularin • qPCR for Total Cyanobacteria (16S rRNA) & Toxin <u>Genes</u> (<u>mycE/ndaF</u>, <u>cyrA</u> & <u>Sxt A</u>)
Filtered water	<ul style="list-style-type: none"> • Cyanobacterial/algal speciation and cell count • T&O measurements - (MIB and Geosmin) • Algal <u>Toxins</u> – Anatoxin-A, Cyndrospermopsin, <u>Deoxycylindrospermopsin</u>, Microcystins as LR, Nodularin
Distributed water	<ul style="list-style-type: none"> • Cyanobacterial/algal speciation and cell count • T&O measurements - (MIB and Geosmin) • Algal <u>Toxins</u> – Anatoxin-A, Cyndrospermopsin, <u>Deoxycylindrospermopsin</u>, Microcystins as LR, Nodularin
Supernatant from wash water	<ul style="list-style-type: none"> • Cyanobacterial/algal speciation and cell count • T&O measurements - (MIB and Geosmin) • Algal <u>Toxins</u> – Anatoxin-A, Cyndrospermopsin, <u>Deoxycylindrospermopsin</u>, Microcystins as LR, Nodularin • Only Phase 2: qPCR for Total Cyanobacteria (16S rRNA) & Toxin <u>Genes</u> (<u>mycE/ndaF</u>, <u>cyrA</u> & <u>Sxt A</u>)

Example of sampling point:



Raw water carbon contact tank. PAC not operational on day of sampling

Raw water sample taken from analyser on inlet pipework to this contact tank



"Clarified Water" sample is from the Floated water turbidity analyser ("sub-natant" sample taken between the float and the filter media)

Filtered water sample from filtered water analyser discharge

Example of sampling point:



"Sludge" sample from DAFF float at Cobram WTP

Example of sampling point:



Filter 5 Backwash Settings			
Run Time Set Point	24.00 Hours	Air Scour Duration Time	180 sec
Headloss Set Point	2000 mm	Low Rate Backwash Time	60 sec
Float BW Duration Time SP	3 mins	Low Rate Flow Set Point	100 l/s
Reducing Drain Enable	<input type="checkbox"/>	Air Purge Open Time	60 sec
Drain Level Drop	3 mm	High Rate Backwash Time	300 sec
Drain Down Time Set Point	120 min	High Rate Backwash Flow	200 l/s
Backwash Trough Level Enable	<input type="checkbox"/>	Double Backwash	<input type="checkbox"/>
Filter To Waste Drain Down Enable	<input type="checkbox"/>	Refill Enable	<input type="checkbox"/>
Waste Drain Time Set Point	0 mins	Ripen Enable	<input type="checkbox"/>
Waste Drain Time Remaining	0.00 mins	Backwash Ripen Time Set Point	20 min
		DW Ripening Time Remaining	20.00 min

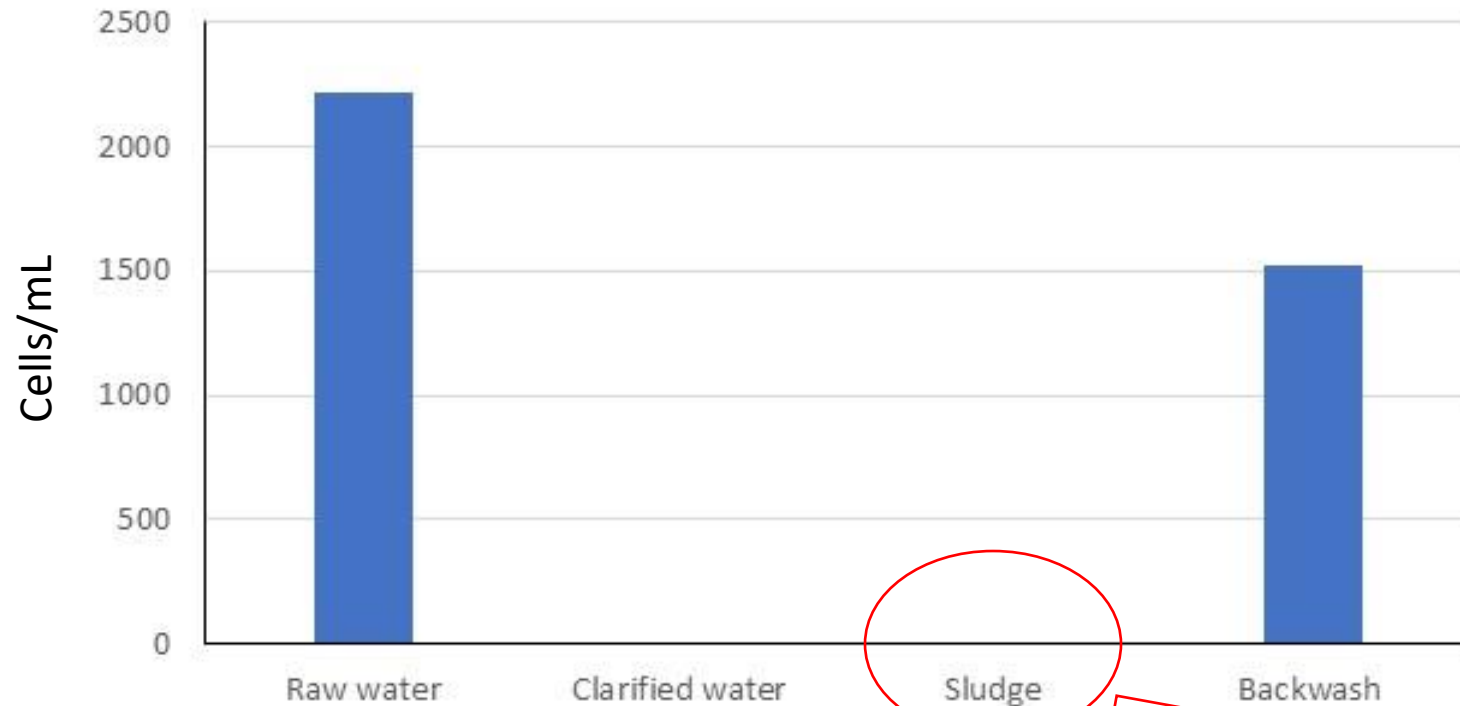


"Supernatant washwater" sample is labeled "backwash" Cobram WTP



Phase 1 results:

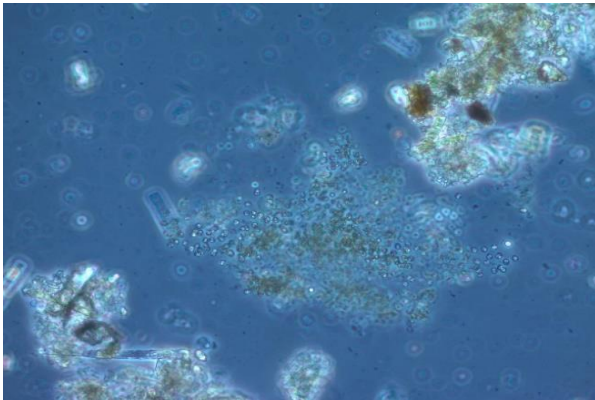
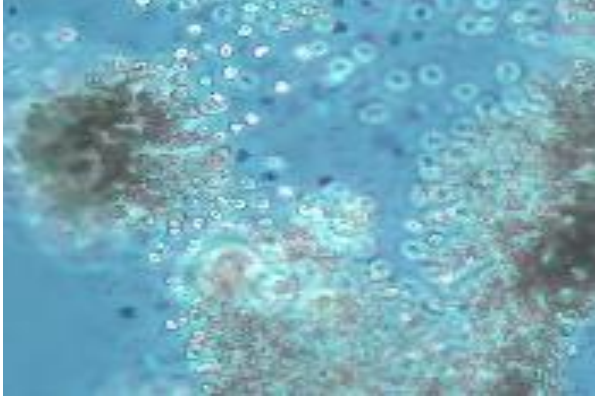
DWTP-K



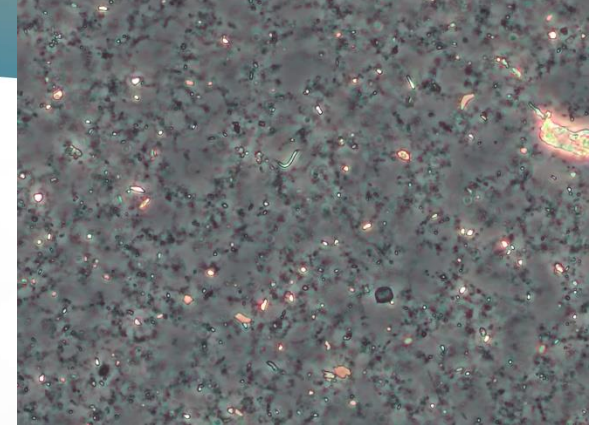
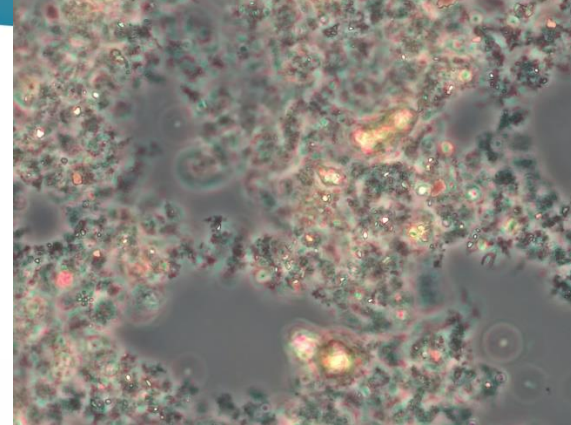
Cyano Toxin qPCR - Total Cyanobacteria (16S rRNA)	copies/mL	3400
Cyano Toxin qPCR - Microcystin/Nodularin gene (mcyE/ndaF)	copies/mL	<18
Cyano Toxin qPCR - Cylindrospermopsin gene (cyrA)	copies/mL	<18
Cyano Toxin qPCR - Saxitoxin gene (Sxt A)	copies/mL	<18

Phase 2 results:

Flocculation - Another taxonomy challenge:



Clarifier sludge taxonomy:



Diatom BACILLARIOPHYCEAE - *Aulacoseira*: 2.8M cells/mL

BGA:

- *Planktolyngbya*: 303K cell/mL
- *Synechococcales*: 517K cells/mL (very small)
- *Microcystis*: 29K cells/mL
- *Dolichospermum*: 62K cells/mL
- *Aphanizomenonaceae*: 39K cells/mL

Voila, here you go! This is what I mean by breakthrough into plants!!!

Bar plot comparison of taxa across a DWTP samples, grouped by resolution:

Raw water:
38 ng/L geosmin

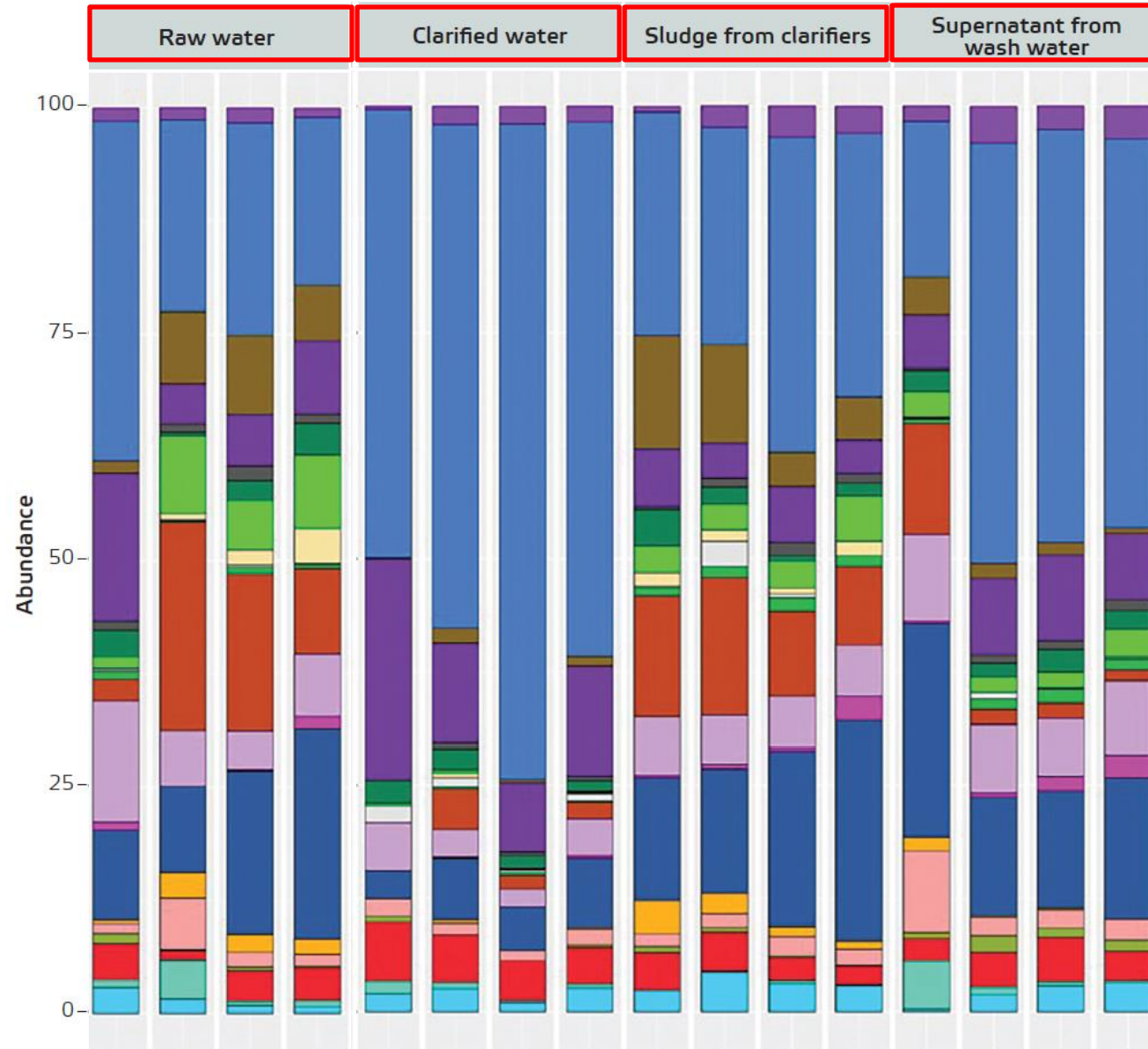


Sludge:
15000 ng/L Geosmin
0.3 ug/L microcystin



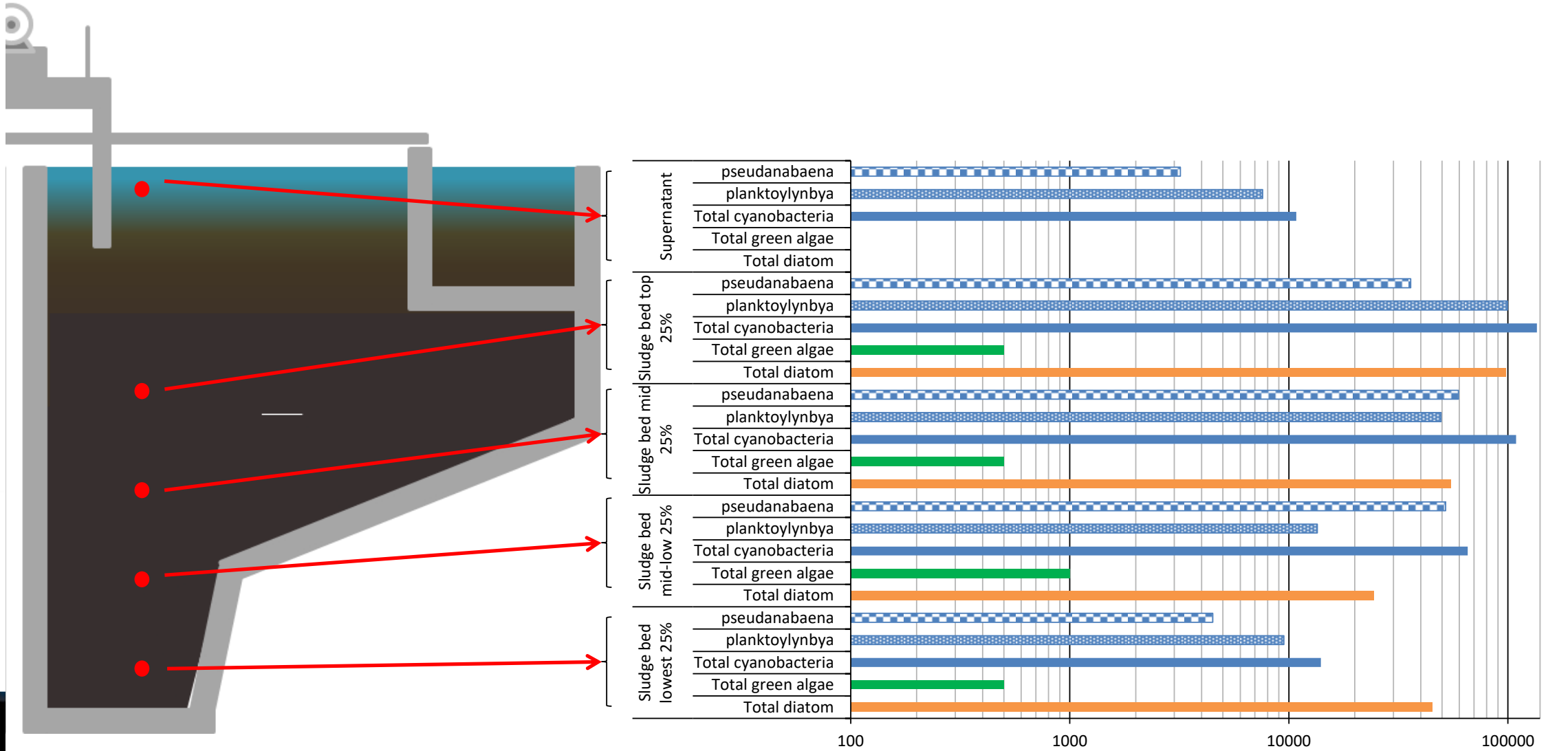
Supernatant wash water:
6 ng/L Geosmin

Filtered water:
4 ng/L Geosmin
0.3 ug/L microcystin



Successful removal of cell and their intracell T&O, as concentrations were low in backwash and filtered water.

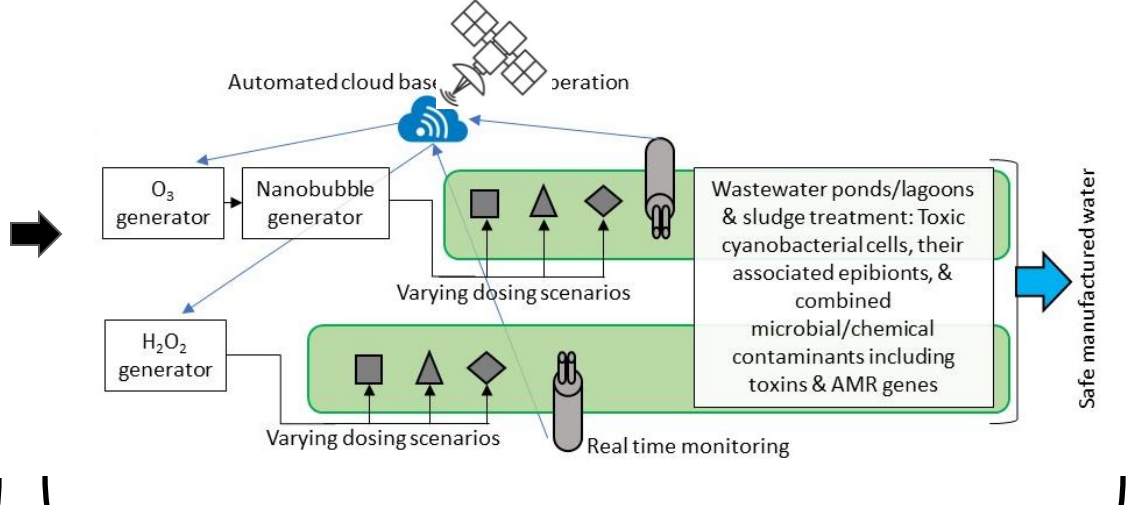
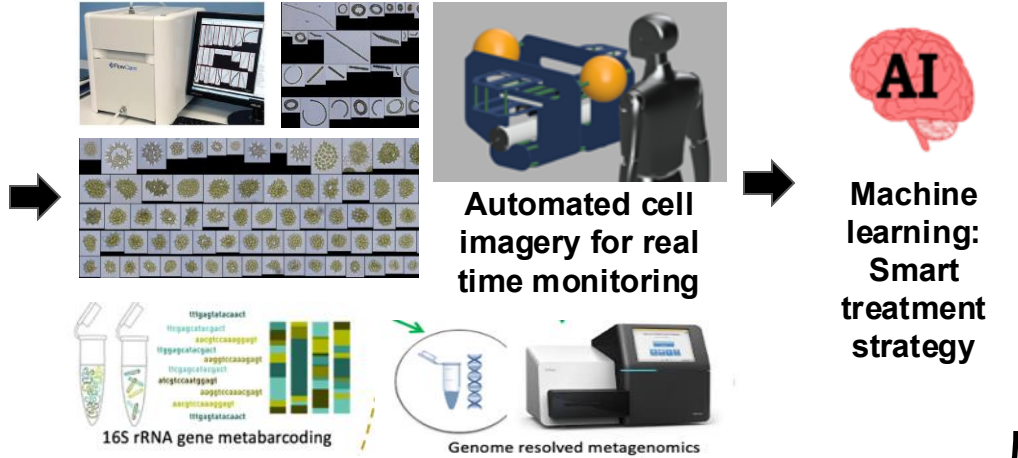
Breakthrough events lead to accumulation of cells inside clarifiers:



Need to develop scalable approaches for treatment in manufactured!



Harmful blooms



Early warning system: Supervised and knowledge-guided machine learning approaches for quantifying and identifying cyanobacteria, algae, and methanogens in water, wastewater and recycled supply and treatment systems

Treatment solution: Scalable approaches for treatment in manufactured water (Hydrogen peroxide and ozone nanobubble AOP)



Computational and Structural Biotechnology Reports 1 (2024) 100014



Contents lists available at ScienceDirect

Computational and Structural Biotechnology Reports

journal homepage: www.sciencedirect.com/journal/csbr



Machine learning driven image segmentation and shape clustering of algal microscopic images obtained from various water types

Filippo Nelli^a, Zongyuan Ge^b, Linda Blackall^c, Negar Taheriashtiani^a, Rebekah Henry^e, Douglas R. Brumley^d, Michael Grace^f, Aaron Jex^{g,h}, Michael Burchⁱ, Tsair-Fuh Lin^l, Cheryl Bertelkamp^{j,n}, Anusuya Willis^k, Li Gao^l, Jonathan Schmidt^l, Nicholas D. Crosbie^m, Arash Zamyadi^{a,*}

<https://doi.org/10.1016/j.csbr.2024.100014>




See our poster!

Large scale dosing H₂O₂ bloom season 2024-2025 & 2025-2026:



1. For surface bloom reduction in cell viability up to 70% was achieved
2. 40-50% reduction in total cell numbers for surface bloom was achieved

REVIEW ARTICLE | OCTOBER 14 2025

Critical review of oxidant application and scalability for managing toxic *Microcystis* blooms in wastewater stabilisation ponds 

Ortal Raikhlin; Nicholas Crosbie; Bojan Tamburic; Xiaoran Chu; Rita Henderson; Brandon Winfrey; Michael Burch; Arash Zamyadi

<https://doi.org/10.2166/wqrj.2025.052>

Next phase:




**Come to our presentation on Wednesday morning about ozone nanobubbles and the
“Nanobubble workshop” Wednesday noon!**

And read our latest results:

New Results

<https://doi.org/10.1101/2025.10.15.682302>

**Exploring use of ozone nanobubbles for removal of cyanobacteria and co-
occurring antimicrobial resistance genes in water supply and reuse systems**

Ushalini Saththiyanathan, Calum J Walsh, Steven Newham, Mark Putmann, Daniel Flanagan, Karen Rouse,
Filippo Nelli, Elnaz Karamati Niaragh, Louise M Judd, Karolina Mercoulia, Torsten Seemann, Ming Su, Min Yang,
Linda Blackall, Benjamin Howden, Eric Wert,  Arash Zamyadi

doi: <https://doi.org/10.1101/2025.10.15.682302>



Trisha Knavel
Drinking Water Quality Officer for Townsville City Council
Industry Doctoral Program - PhD Candidate at Monash University



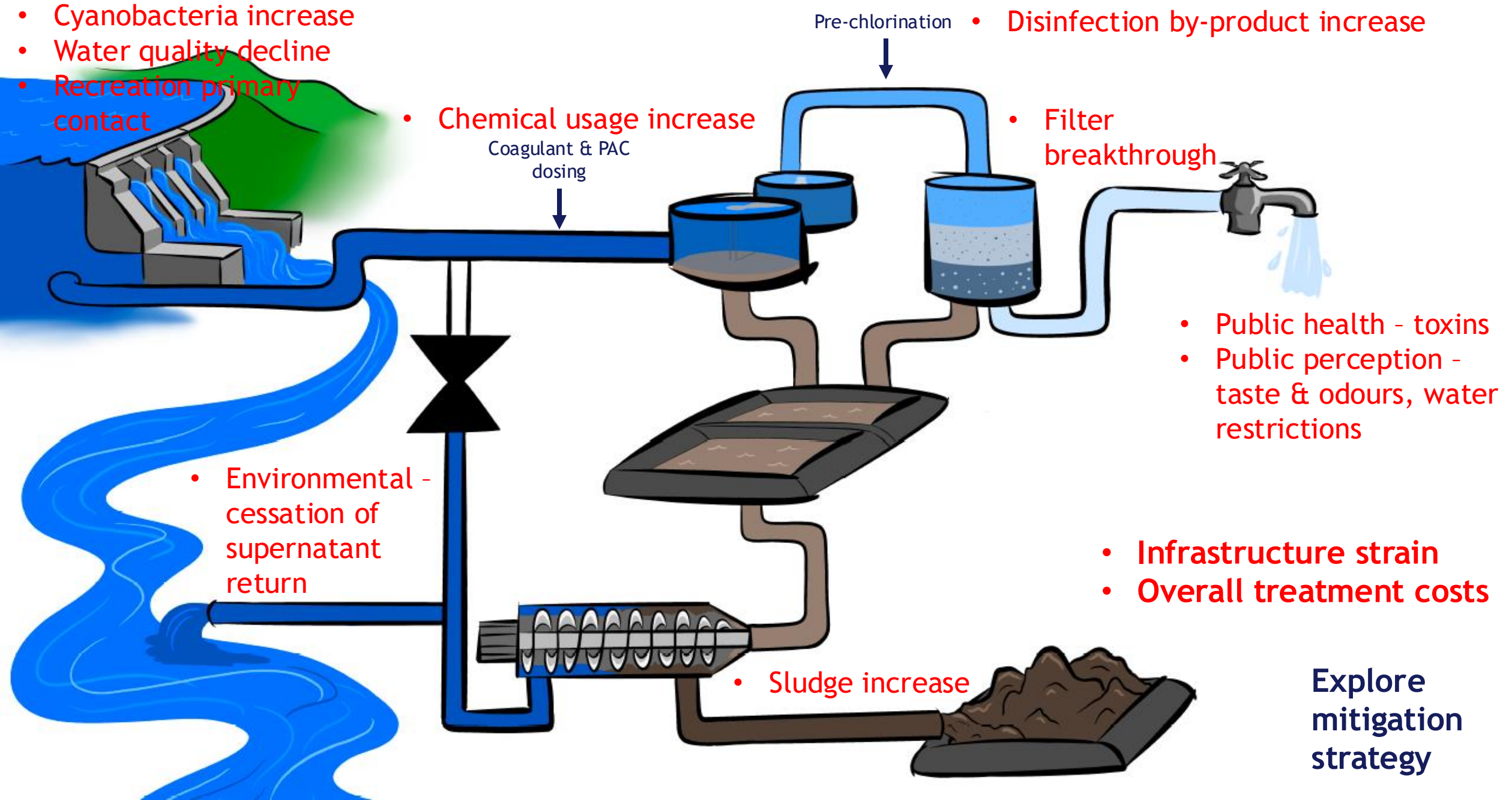
MONASH
University



Managing Cyanobacteria Risk

Challenges and Opportunities from Townsville's Experience

Identifying Risks through Treatment Process





Scalable approaches for detection & elimination of microbial threat from manufactured water

Shorouq:

Negar: AI

Ortal: AOP

Ushalini:

Trish:

Amaya: H₂



THANK YOU!



Contact: arash.zamaydi@monash.edu



Dr Anusuya Willis
Director, Australian National Algae Culture Collection, CSIRO

9th Australian and New Zealand Cyanobacteria Workshop

CSIRO Marine Labs, Hobart, Tasmania,
23 – 24th September, 2025

- 140 attendees:
 - Researcher and students
 - Water Managers
 - Algae identifiers
 - Utility operators



- **Elicitation workshop:**
to identify critical **research needs and industry challenges**, propose corresponding solutions, and outline necessary collaborations.



Research needs and industry challenges



1. Standardisation, collaboration and modernization:

- Cyanobacteria analysis
 - Inconsistencies in analytical methods and reporting
 - Inconsistent regulatory guidelines between states and jurisdictions.
- Hinders effective national oversight, data comparison, rapid response to emerging threats.

2. Lack of centralized knowledge and collaborative infrastructure.

- Loss of institutional knowledge
- Failure to build upon pre-existing findings
- Guidelines lack local context

3. Shortage of skilled phycologists

- Call to embrace new tech: AI, eDNA, rapid on-site diagnostics.
- Knowledge gaps: benthic algae, climate change, toxin identification.

Proposed Solutions and Impacts

1. Path to National Cohesion

- Creation of Australian Standards: ensure consistency and transparency
- National Reporting Framework
- Technical Advisory Group
- Taxonomist network

2. A connected ecosystem

- Centralised Hubs and Databases
- Factsheets
- Guidelines
- Expert contact list

3. Modernizing guidelines, taxonomy and technology

- Wider consultation for guidelines
- Embracing new technologies
- Development of rapid on-site testing



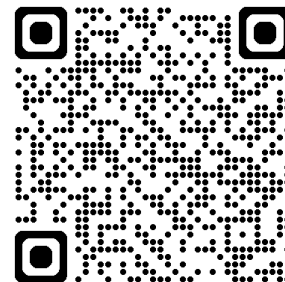
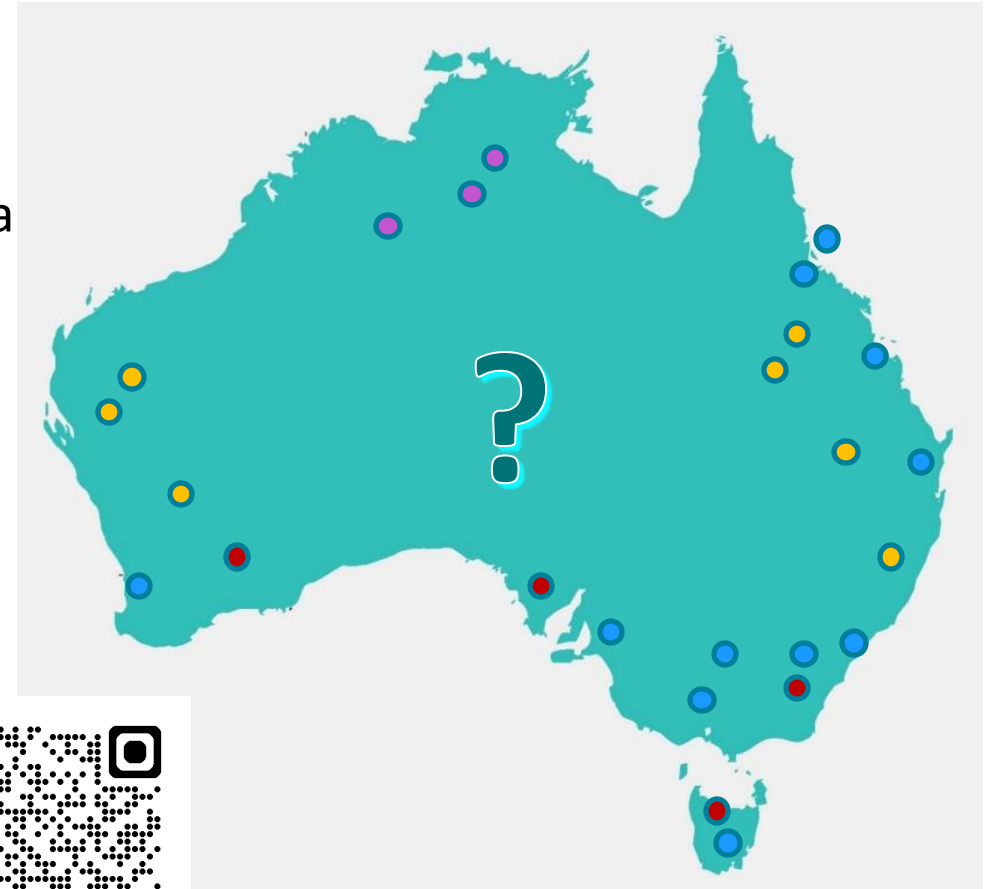


Australia wide – Cyano Survey (v2)

- Metagenomic characterisation of water samples
 - map of cyanobacteria species presence across Australia
 - identify toxin gene cluster presence
- Samples collected and sent to ANACC
 - living sample: isolation
 - filtered and preserved in RNAlater: genomics only

Participate:

- email: anusuya.willis@csiro.au / anacc@csiro.au
- Web: research.csiro.au/AusCyanos





Thank you

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Australian National Algae Culture Collection

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CSIRO, Hobart, Tasmania Australia

Australian National Algae Culture Collection

Our collection is a significant resource holding living cultures of >1200 Australian micro- and macro-algae strains. The collection supports research and is accessed by industry, universities and researchers.

